

## Research Section

# Knowledge sharing in heterogeneous collaborations – a longitudinal investigation of a cross-cultural research collaboration in nanoscience

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In times of globalization and rapidly developing R&D systems, the importance of international collaborative research activities increases, leading to a growing number of heterogeneous collaborations. Especially considering the cultural diversity of such collaborations, intensive cross-cultural knowledge sharing becomes a prerequisite for collaborative success. This paper investigates personal and cultural incentives and barriers influencing the intention to share knowledge of Chinese and German collaborators in an academic setting, employing a linear regression analysis and Chow tests. We can demonstrate that the factors sense of self-worth, loss of knowledge power, guanxi and face saving have an influence on an individual's intention to share knowledge. Further we find significant differences in our Chinese and German subgroups that can be related to cultural impacts. The obtained results provide practical and theoretical implications for the improvement of cross-cultural knowledge sharing in collaborative R&D project.

## 1 Introduction

Nowadays, researchers are facing highly complex problems, rapidly changing technologies and a dynamic growth of knowledge, due to the expansion of science on several axes, e.g. geographical, economical, multidisciplinary and multinational axis (Galison and Hevly, 1992). Often, individual academic scientists can no longer provide all of the expertise and resources necessary to address large

research projects (Hara et al., 2003). Furthermore, these characteristics of modern research encourage scientists to get involved in collaborative research (Soohe and Bozeman, 2005). Generally, research collaborations<sup>1</sup> can emerge between companies (C-C), companies and universities/research institutes (C-U) or universities (U-U).<sup>2</sup>

In particular, increasing global competition disposes companies to take advantage of synergy effects by intensifying global colla-

1) Misleadingly, the terms 'cooperation' and 'collaboration' are often used synonymously. Further similar terms for example are: 'alliance', 'confederacy', 'joint-venture', 'coalition', or 'partnership' (Müller, 2006). Cooperation is characterised by "an interaction process in which the individuals share a common goal and interact in a coordinated way". Coordination means some kind of superordinated entity that exerts influence on the proceedings of each group member with regard to the common goal (Gronau, 2002). On the contrary, collaboration does not need such a coordination function. Collaboration just "means that people work together to achieve a single common result in which contributions of individuals are unified" (Han, 1997).

2) In this paper we subsume research institutes and universities.

boration (Lam, 1997). Thereby, growth, expansion, exchange and generation of knowledge and technology represent the main reasons for joint C-C research activities (Campione, 2003; Odenthal et al., 2002).

The intentions of collaborators to strive for C-U collaboration differ. In addition to capitalizing on cost savings and access to the latest technology, companies utilize this kind of collaboration to open up cost-effective recruiting channels, to access laboratory usage, to share risks for basic research and to stabilize long term research projects (Azarloff, 1982; Bonaccorsi and Piccaluga, 1994; Cyert and Goodman, 1997; Rohrbeck and Arnold, 2006). In contrast, universities engaging in C-U collaborations strive for the enhancement of teaching, followed by achievement of funding and enhancement of reputation. Further motivations supporting collaborative behavior are to be found in the possibility of exchanging knowledge with industrial researchers, access to empirical data and job opportunities for graduates (Hurmelinna, 2004; Meyer-Krahmer and Schmoch, 1998).

However, in all types of collaborations and especially in academic ones knowledge sharing represents a main incentive e.g. by means of getting access to external knowledge on the one hand. On the other hand knowledge sharing is a prerequisite for successful collaboration (Hara et al., 2003; Niedergassel and Leker, 2008; Qian et al., 2008). Knowledge sharing has been in the focus of research for more than a decade and can be defined as the deployment of knowledge from a source to a recipient in communication (Berends et al., 2006). Following Nonaka, we define knowledge as justified true belief (Nonaka, 1994). Since knowledge is subjective and related to an individual's experiences, knowledge sharing is embedded in a certain cognitive and behavioral context (Michailova and Hutchings, 2006). Qian et al. identified personal and cultural factors that impact on knowledge sharing (Qian et al., 2008). Niedergassel developed a conceptual framework with influencing factors for knowledge sharing in collaborative R&D projects (Niedergassel, 2009). He hypothesizes an influence of knowledge tacitness, knowledge newness, physical proximity, frequency of personal communication, trust between partners, pre-existing relationships, interdependency of partners, redundancy of

knowledge sets and closeness of partners on knowledge sharing (Niedergassel, 2009).

While knowledge sharing in C-C collaborations has been widely discussed in the existing body of literature (Abrams, 2003; Cantner and Meder, 2007; Hansen, 1999; Hansen, 2002; Kaser and Miles, 2002; Lam, 1997; Levin and Cross, 2004; Reagans and McEvily, 2003), less effort has been made in analyzing knowledge sharing in academic collaborations (Hara et al., 2003; Niedergassel, 2009). In times of globalization and rapidly developing R&D systems, academic researchers increasingly strive for geographically distributed collaborations (Galison and Hevly, 1992; Hara et al., 2003). This leads to a constantly growing number of heterogeneous collaboration.<sup>3</sup> Generally, heterogeneous collaborations are characterized by an inequality of the collaborating partners. Heterogeneity can occur on several dimensions. First, depending on contract situations between collaborators, unequally distributed hierarchy can cause heterogeneity. Second, heterogeneity can arise in research disciplines, e.g. when researchers from different scientific backgrounds are working on interdisciplinary projects. Third, the geographic distribution of the partners' research basis can cause heterogeneity. Fourth, company and/or national culture can differ between collaborating partners, leading to heterogeneity.

In sight of the discussed increase in geographically distributed collaborative partnerships, especially cultural heterogeneity can cause serious difficulties in collaborative knowledge sharing activities. Thus, the understanding of cultural influences on knowledge sharing behavior is gaining importance. Still, only few studies analyzed cross-cultural knowledge sharing and they exclusively focused on C-C collaborations. Chow et al., for instance, analyzed the impact of collectivism versus individualism on the knowledge sharing behavior of Chinese and U.S. American individuals (Chow et al., 2000). Similarly, Michailova and Hutchings compared knowledge sharing in Russia and China focusing on collectivism/individualism and universalism/particularism (Michailova and Hutchings, 2006). Zhang et al. on the other hand investigated the impact of in-group/out-group affiliation on knowledge sharing in a cross-cultural setting (Zhang et al., 2008), which Chow indicated as well (Chow et al., 2000). Referring

3) Heinze and Kuhlmann define heterogeneous research collaboration as collaboration across institutional boundaries (Heinze and Kuhlmann, 2006). However, we expand the scope beyond the organizational dimension.

to Chow, Michailova and Hutchings, Ardichvili emphasized the importance of the cultural factors collectivism/individualism, in-group/out-group orientation, fear of losing face, and the importance of status and power distance, in his research on culture-specific barriers to knowledge sharing in China, Russia and Brazil (Ardichvili et al., 2006).

Contributing by filling the research gap regarding cross-cultural knowledge sharing in academic settings, we investigate different intentions to share knowledge in the first Chinese-German research collaboration on Nanoscience. Particularly, we focus on personal and cultural factors impacting the collaborators' intention to share knowledge, employing a longitudinal research approach.

In the course of this paper, we first describe our research framework. Second, we present cultural factors differing between Chinese and German societies. Third, the Social Exchange Theory will be discussed and used to explain knowledge sharing behavior. Afterwards, we will present our hypotheses concerning the factors potentially impacting the intention to share knowledge. Subsequently, we will characterize our methodology, followed by a presentation of the results. Finally, a discussion and conclusion will summarize the findings of this paper, providing recommendations and practical guidelines for improving the process of knowledge sharing.

## 2 The Transregional Collaborative Research Centre: a heterogeneous collaboration

The "Transregional Collaborative Research Centre" (TRR 61) represents the first academic Chinese-German research collaboration on Nanoscience and is entitled "Multilevel Molecular Assemblies: Structure, Dynamics and Function". Participants within the TRR 61 are the University of Münster (Germany), the Cen-

tre for Nanotechnology (CeNTech), the Centre for Nonlinear Science (CeNoS), the Tsinghua University (Beijing, China), the Chinese Academy of Science, the Interdisciplinary Research Centre for Cooperative Functional Systems (FOKUS) and the Chinese National Centre for NanoScience & Technology (NCNST, Beijing/China). Inspired by natural systems and their properties, chemists, physicists and biologists are working on the interdisciplinary field of functional molecular and nano object assemblies. Participants of the TRR 61 are hierarchically equal and their knowledge is accessible for everybody within the TRR 61. The TRR 61 demonstrates heterogeneity on the disciplinary, the cultural and the geographical dimension, representing an ideal opportunity to investigate cultural impacts on knowledge sharing activities.

## 3 Cultural differences between China and Germany

Based on an analysis of Geert Hofstede (5D-model) concerning five cultural dimensions (Power Distance Index, PDI; Individualism, IDV; Masculinity, MAS; Uncertainty Avoidance Index, UAI; Long-Term Orientation, LTO),<sup>4</sup> Germany and China feature opposed parameter values in all dimensions, except Masculinity. The scores of China and Germany in Hofstede's 5D-model are presented in Figure 1.

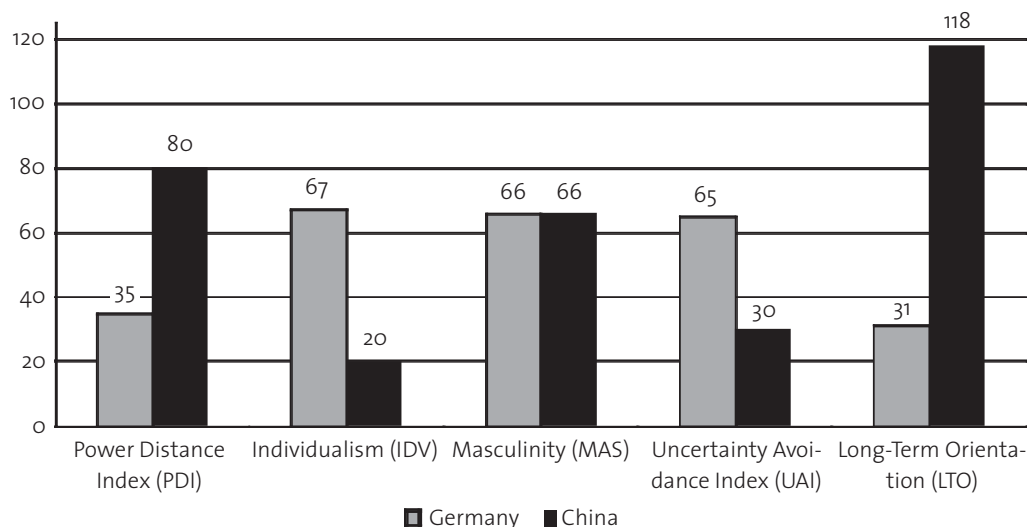
The PDI of China (80) is higher than the PDI in Germany (35), indicating a higher level of inequality of power and wealth in the Chinese than in the German society. Moreover, in China subordinates are unlikely to approach and contradict their supervisor in a direct way, while German subordinates will do so more likely (Hofstede and Hofstede, 2007).

The IDV scores are considerably higher in Germany (67) than in China (20), meaning that the German society is oriented towards individualism and the Chinese society is oriented

4) A detailed description can be found in Hofstede (2007):

- PDI: Power distance is defined as the extent to which the less powerful members of institutions and organizations within a society expect and accept that power is distributed unequally.
- IDV: Individualism is the opposite of collectivism. Individualism stands for a society in which the ties between individuals are loose: a person is expected to look after himself or herself and his or her immediate family only. Collectivism stands for a society in which people from birth onwards are integrated into strong, cohesive in-groups, which continue to protect them throughout their lifetime in exchange for unquestioning loyalty.
- MAS: Masculinity is the opposite of femininity. Masculinity stands for a society in which emotional gender roles are clearly distinct: men are supposed to be assertive, tough, and focus on material success; women are supposed to be more modest, tender, and concerned with the quality of life. Femininity stands for a society in which emotional gender roles overlap: both men and women are supposed to be modest, tender, and concerned with the quality of life.
- UAI: Uncertainty avoidance is defined as the extent to which the members of institutions and organizations within a society feel threatened by uncertain, unknown, ambiguous, or unstructured situations.
- LTO: Long-term orientation is the opposite of short-term orientation. Long-term orientation stands for a society that fosters virtues oriented towards future rewards, in particular perseverance and thrift. Short-term orientation stands for a society that fosters virtues related to the past and present, in particular respect for tradition, preservation of 'face', and fulfilling social obligations."

Figure 1 Comparison of Chinese and German scores in Hofstede's 5D-model.



towards collectivism. Thus, in the individualistic Germany tasks always prevail over personal relations and vice versa in the collectivistic China. According to Hofstede, Chinese-German cooperation shows differences in social and group orientation, respectively. Whereas the German managers' way of thinking and operating is affected by individualism, Chinese managers orient their behavior towards collectivism (cf. IDV) (Valentine and Godkin, 2001).

Basically, this effect is derived from utterly heterogeneous political orientations, as well as from the importance of the family, traditionally founded in the long history of China (Ho, 1976). On this basis it is conjecturable that the collaboration propensity will be more pronounced for Chinese (Birnholtz, 2007).

China and Germany show equal scores (66) in masculinity, representing equal occurrence of clearly distinct emotional gender roles. In contrast, considerable differences emerge in the factor UAI. The scores in the UAI are higher in Germany (65) than in China (30). This indicates that there are more formal laws, informal rules and work regulations controlling the rights and duties of individuals in Germany than in China. In countries showing a low degree of uncertainty avoidance like China, one believes that many problems can be resolved without rules and that rules should only be established if absolutely necessary. Furthermore, in countries with a high degree of uncertainty avoidance orientation individuals like to be always busy and hard working or at least like to be seen so, while in low uncertainty

avoidance countries individuals are able to work hard when needed, but they are not "driven by an inner urge toward constant activity" (Hofstede and Hofstede, 2007).

The greatest difference between the Chinese and the German culture according to Hofstede is found in LTO. China has the highest score (118) of all countries and Germany (31) is ranked with a low LTO score. Hence, culturally based differences between China and Germany in the concept of time are expected. Thereby, in contrast to Germans, Chinese do not think about time in terms of "time is money". Since in China time appears as a relatively unlimited and cheap good, Chinese are more focused on the long-term outcome rather than on obtaining short-term success as it is to be found in Western countries (Wilpert and Scharpf, 1990).

Besides the Hofstede dimensions, cross-cultural researchers emphasize further important factors for the Chinese culture, namely *guanxi* (simply translated as 'personal connections/relationships') and the concept of *face* (Easterby-Smith and Malina, 1999; Ho, 1976; Jarman, 2001; Jiwen and James, 2007; Qian et al., 2008; Wilpert and Scharpf, 1990). Further factors affecting cross-cultural collaborative effectiveness are differing concepts of quality, differing respect for age and hierarchy and the use of third language communication (mainly English) (Wilpert and Scharpf, 1990). According to previous research on cross-cultural knowledge sharing, e.g. studies conducted by Ardichvili, Michailova and Hutchings

or Zhang, we argue that *guanxi* and the concept of face exert main impacts on knowledge sharing processes (Ardichvili et al., 2006; Michailova and Hutchings, 2006; Zhang et al., 2008). Thus, *guanxi* and the concept of face are discussed in detail in the following paragraphs.

*Guanxi* is mostly described as a form of interpersonal relationships and connections unique to the Chinese culture. Due to the high value of harmony in the Confucian oriented Chinese society, Chinese tend to emphasize good relationships in their social environment (Qian et al., 2008). Luo describes six traits that offer a comprehensive understanding of *guanxi* (Luo, 1997). First, *guanxi* is based on a utilitarian concept and therefore bonds individuals by exchanging favors rather than feelings. A *guanxi* relation not necessarily involves friends, however, if possible friends are preferred (Dunning and Kim, 2007). Ties based on *guanxi* are easily broken when they are not perceived to help in achieving goals. Second, *guanxi* means reciprocal exchange of favors and frequently tends to favor the weaker relation partner (Alston, 1989). Third, *guanxi* is transferable in the way that if A has *guanxi* with B, and A has *guanxi* with C, he can suggest B to C or vice versa. Fourth, *guanxi* is operating on the individual level and thus a highly personal concept. Hereby, trust, honesty, reciprocity, respect and social status are the essential features (Davies et al., 1995). In China, interpersonal loyalty is often more important than organizational affiliation or legal status (Dunning and Kim, 2007). Fifth, *guanxi* is directed to long-term interpersonal associations and interactions. Sixth and lastly, *guanxi* has an intangible quality, i.e. individuals who share *guanxi* ties are committed to each other by an “informal and unwritten code of trust, forbearance, reciprocity and equity” (Dunning and Kim, 2007). Disrespecting the virtues of *guanxi* can easily cause serious damage to an individual’s social standing and respectability.

The social standing of an individual is closely connected to the amount of ‘face’ an individual can claim for him/herself. Even though the concept of face is universally applicable to rank an individual’s standing in his social environment, the Chinese interpretation of face is specifically oriented to status and fixed role behavior (Wilpert and Scharpf, 1990). According to Leung and Chan, face is the “respect, pride and dignity of an individual as a consequence of his/her social achievements and the practice of it” (Leung and Chan, 2003).

Cardon and Scott argue that face in China is an essential component of communication and relates to a person’s image and status within a social structure, while Westerners’ view of face is fairly simple and separated from communication (Cardon and Scott, 2003). Face has versatile characteristics. First, an individual’s face has a certain quantity, which can be increased by hard work, benefiting society, superior intellectual knowledge, accumulation of wealth and exemplary behavior, for instance (Brunner et al., 1989). Second, face has a positional aspect, i.e. the face position of individuals is generated by their social network and connections (Hwang, 1982). The larger the network and the more powerful the members connected to an individual the higher the face position. Third, face has a moral dimension, representing the confidence of society in the integrity of an individual’s character (Leung and Chan, 2003). Fourth, face has a dimension related to one’s prestige and reputation achieved through success and ostentation (Brunner et al., 1989). Fifth, in social interactions Chinese generally focus on saving face, giving face and avoiding a loss of face to others always under the unwritten law of reciprocity (Leung and Chan, 2003; Qian et al., 2008; Wilpert and Scharpf, 1990). Sixth and lastly, face can be transferred, i.e. buying face or borrowing face is a common praxis meaning that an individual may ask another one with a high social standing to intervene on his behalf, where the individual has not enough face (Cardon and Scott, 2003). Concluding, one has to note that Chinese collaboration partners might use face-related communication strategies to save or give face to others, e.g. indirectness, intermediaries on the one hand and praising or requests on the other (Cardon and Scott, 2003). Despite the critics to Hofstede’s survey and dimensions (for instance: Baskerville, R.F. (2003)) his framework has found broad acceptance and is often applied in academic research.

#### 4 Research construct and hypothesis

The use of collaboration as a tool of science became an essential prerequisite particularly in “big science”, which is characterized by large-scale projects dealing with complex, rapidly changing problems and dynamic and highly specialized knowledge (Galison and Hevly, 1992; Hara et al., 2003). Moving from closed research to open research or even open innovation approaches, external knowledge

sourcing and knowledge sharing become important requirements for universities (Lichtenthaler and Ernst, 2006). Often such collaborations are affected by “diversity of nationality, gender, ethnicity or profession” (Melin, 2000). Especially geographically distributed collaborators have to cope with further specific challenges, such as providing effective communication channels (e-mail, computer-networks, phone calls, etc.) and overcoming difficulties in project coordination to assure success (Birnholtz, 2007; Cummings and Kiesler, 2003; Cummings and Kiesler, 2005; Finholt, 2003). Otherwise, ideas or information pertaining to research and measuring instruments cannot be exchanged. However, sharing knowledge across long distances still remains complicated (McFadyen and Cannella Jr, 2005).

### Social Exchange Theory and knowledge sharing

Whenever, deciding whether to participate in knowledge sharing activities, rational individuals will consider costs and benefits of such interactions (Qian et al., 2008). Therefore, the Social Exchange Theory (SET) can be employed to explain such situations. The SET argues that the exchange between individuals is a fundamental form of behavior and based on cost-benefit principles (Homans, 1961). Furthermore, Homans introduced psychological concepts like expectations and rewards and Blau introduced the concept of social reward, bridging the gap between individuals and society (Blau, 1964). Thibaut and Kelley propose that e.g. anticipated reciprocity and expected gain in reputation motivate individuals to participate in social exchange activities (Thibaut and Kelley, 1959). In contrast to economic exchange, social exchange occurs without specific obligations, i.e. roles or contracts. Thus, individuals do others a favor via such exchanges with the expectation of some future return, even without having a definite guarantee of this return. These characteristics match the knowledge sharing concept. Hence, we argue that knowledge sharing could be regarded as a kind of social exchange.

The SET is often applied to knowledge sharing processes as a theoretical basis (Bock et al., 2005; Niedergassel, 2009). Kankanhalli employed SET to investigate individual behavior in knowledge sharing (Kankanhalli et al., 2005). She focused on ‘costs and benefits’ according to SET for the analysis of incentives and barriers in knowledge sharing. Chua for instan-

ce employs a multi-person game-theoretic framework, however, he emphasizes reciprocity in knowledge sharing, declaring consistency with SET (Chua, 2003). Constant et al., using SET, argue that self-interest is an impeding factor for knowledge sharing (Constant et al., 1994). Bartol and Srivastava analyze how to design effective rewards for knowledge sharing via social exchange (Bartol and Srivastava, 2002).

Employing SET in our investigation of knowledge sharing behavior we conduct an economic analysis of noneconomic social exchanges (Emerson, 1976), thus we argue that applying the terms incentives and barriers for knowledge sharing as a noneconomic social exchange instead of the economic exchange terms benefits and costs is more appropriate. Hereby, we especially focus on individuals’ personal incentives and barriers and cultural impacts that could enhance or reduce their intention to share knowledge. Particularly, we developed four hypotheses.

In literature, the sense of self-worth seems to be a main incentive for an individual to share knowledge. Individuals are more willing to participate in knowledge sharing activities if they believe that their contribution is valued by others (Cabrera and Cabrera, 2002). Since participants can evaluate the usefulness of their knowledge through feedback in knowledge sharing activities, they can achieve an enhancement of their feeling of self-worth (Bock et al., 2005; Qian et al., 2008). Due to the individualistic orientation of the German culture, we argue that the sense of self-worth is more important to Germans than to Chinese.

Besides, giving and receiving feedback as a facilitator of knowledge sharing should be more direct and distinctive in Germany due to the lower power distance index. Thus we hypothesize:

*Hypothesis 1: The sense of self-worth has a stronger positive influence on the intention to share knowledge in the German group than in the Chinese group.*

On the contrary, a main barrier could be the loss of knowledge power caused by sharing of an individual’s unique knowledge. Previous studies suggested that individuals might be afraid to lose their competitive advantage by sharing knowledge, which they gained little by little throughout experience, failure and frustration and which enables them to exceed

their colleagues' performance (Kankanhalli et al., 2005; Qian et al., 2008). Although knowledge sharing could benefit themselves and the project, those might hold onto their knowledge if they believe to receive greater benefits by doing so (Davenport and Prusak, 2000). Due to the German tendency towards individualism, where everybody looks after himself and individual success is often more important than group success we hypothesize:

*Hypothesis 2: The loss of knowledge power has a stronger negative influence on the intention to share knowledge in the German group than in the Chinese group.*

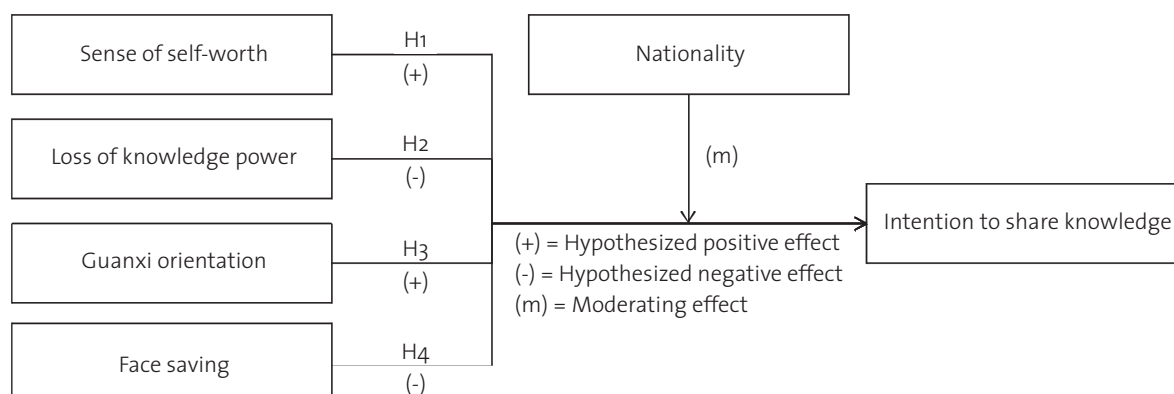
In addition, cultural differences can cause difficulties and asymmetry in knowledge sharing (Lam, 1997; Zhang et al., 2008). Due to the different ways in which knowledge and skills are generated, organized, shared and utilized in different societal settings, one can expect an impact of culture when it comes to cross-cultural knowledge sharing (Lam, 1997; Zhang et al., 2008). Interpersonal networks and connections have an important influence on knowledge sharing (Weir and Hutchings, 2005). Further, social ties, including trust and rapport have a positive impact on knowledge sharing (Qian et al., 2008). Besides, Kotlarsky and Oshri argued that guanxi would promote knowledge sharing between partners (Kotlarsky and Oshri, 2005). A study conducted by Qian et al. in China demonstrates that guanxi orientation has a positive relationship with

the intention to share knowledge (Qian et al., 2008). Since Chinese are very eager to maintain good relationships with people in their environment, they have a high guanxi orientation. Thus we hypothesize:

*Hypothesis 3: The guanxi orientation has a stronger positive influence on the intention to share knowledge in the Chinese group than in the German group.*

The amount of face an individual has can vary constantly (Ho, 1976). During the course of social interactions like knowledge sharing an individual's face could be enhanced or diminished (Qian et al., 2008). Ardichvili et al. proposed that the desire of face saving is a barrier in knowledge sharing processes (Ardichvili et al., 2006). Accordingly, Qian et al. found a negative influence of face saving on the intention to share knowledge in their study (Qian et al., 2008). Individuals could be afraid that the knowledge they intend to share might be incorrect. Hence, sharing incorrect knowledge displays their ignorance and would thereby cause a loss of face. Therefore, individuals who try to save face would probably not participate in knowledge sharing activities. Furthermore, in order to save face people might restrict their behavior even to the extent of avoiding contact with others (Qian et al., 2008). Since the concept and the consequences of face are a more salient characteristic of the Chinese culture, we hypothesize:

Figure 2 Research concept and hypotheses.



*Hypothesis 4: Face saving has a stronger negative influence on the intention to share knowledge in the Chinese group than in the German group.*

Figure 2 summarizes the discussed hypotheses.

## 5 Data collection and measures

Due to the fact that our research project is part of the research objective TRR 61 itself, we have a unique opportunity to gather data on a chronological sequence of activities that occur throughout the collaboration. A standardized online questionnaire was developed in a two stage process. First, a literature review was performed to identify adequate constructs. In the questionnaire, we used existing scale items from previous studies where applicable and adapted these to the context of cross-cultural academic collaboration where necessary. Regarding the factor *sense of self-worth*, we employed the scale of Bock et al. (Bock et al., 2005). *Loss of knowledge power* was measured by the scale of Kankanhalli (Kankanhalli et al., 2005). *Guanxi orientation* was measured by the scale of Zuo (Zuo, 2002). We reformulated two of the six items to adapt them to the cross-cultural context. Concerning the factor *face saving* we used the scale introduced by Cheung et al. (Cheung et al., 2001). Finally, we employed the three-item scale by Ryu to measure the *intention to share knowledge* (Ryu et al., 2003). The response format was a 5-point Likert scale (ranging from 1 'I strongly disagree' to 5 'I strongly agree').

Second, a pretest was performed by sending the questionnaire to selected university scientists, resulting in minimal changes (see Appendix for an overview of used items and constructs; the original questionnaire contained additional items not presented in this paper). All TRR 61 scientists were approached by personalized emails. A reminding email was sent out after 20 days, a second reminder was sent out after another 20 days and the survey was terminated 60 days after our first approach. Overall, we could obtain 49 responses, representing a response rate of 80%. 6 datasets had to be eliminated due to incomplete answers, leading to a final sample size of  $N = 43$  ( $n_{\text{China}} = 17$ ;  $n_{\text{Germany}} = 26$ ).

## 6 Analysis and results

In the first step of our analysis, we conducted a factor analysis to determine the structure of the employed constructs. Unidimensionality of the constructs was assessed employing an exploratory factor analysis. Cronbach's alpha values were used to evaluate the reliability of the measures (Cronbach, 1951). We could show unidimensionality for all constructs except face saving, which did not exceed the commonly suggested threshold value of .70 (see Appendix for factor loadings and Cronbach's alphas). However, to maintain the richness of the analysis, we decided not to further purify these constructs. Besides, we assessed the discriminant validity of the constructs by comparing variance extracted (VE) percentage with the squares of the correlation estimates, as proposed by Fornell and Larcker (Fornell and Larcker, 1981). Discriminant validity could only be demonstrated for loss of knowledge power and guanxi orientation. However, the global criteria and more than 50% of partial criteria are met; thus, all constructs are retained for further analysis.<sup>5</sup> The goodness-of-fit can be considered acceptable for the overall model (GFI = .969; AGFI = .960; RMR = .072).

Harman's single factor test was employed to address the issue of common method bias. The test indicates substantial common method bias if only one single factor emerges from exploratory factor analysis or one general factor accounts for more than 50% of the covariance between the measures. We could find neither of these conditions applying Harman's single factor test to our sample.

In the second step, we constructed linear regression models with *the intention to share knowledge* as the dependent variable for each factor, i.e. *sense of self-worth*, *loss of knowledge power*, *face saving* and *guanxi orientation*. Our hypotheses indicate differing impacts of the factors on the *intention to share knowledge* depending on the cultural background. Accordingly, a statistical method to test the effect of a variable on the direction or the strength of a relation between an independent and a dependent variable is a moderator analysis (Baron and Kenny, 1986). In our moderator analysis the dependent variable is

5) First generation criteria: Variance explained in Exploratory Factor analysis > 50%, Factor loading > .40, Cronbach's alpha > .60. Second generation global criteria: GFI > .90, AGFI > .80, RMR < .10. Second generation partial criteria: Item reliability > .40, Construct reliability > .60, Average percentage of variance extracted > .50, fulfillment of Fornell-Larcker criterion (Fornell and Larcker, 1981).



the *intention to share knowledge*, the independent variables are *sense of self-worth*, *loss of knowledge power*, *face saving* and *guanxi orientation* and the moderating variable is *nationality*. Further, we followed the framework for identifying moderator variables developed by Sharma (Sharma et al., 1981). According to Hambrick, we conducted Chow tests to test our hypotheses (Hambrick and Lei, 1985).

The Chow test for homogeneity of regression results is a straightforward method to observe differences in regression results and found broad acceptance (Hambrick and Lei, 1985). First, we ran separate regressions for the two subsamples. Second, we ran the regressions for the total sample. The values of interest were the sum of squared errors for the total sample and the subsamples. If the errors obtained from the subsamples are small relative to the errors of the total sample, a moderating effect can be assumed. In Table 1, results for the four different regression models are reported.

For the interpretation of the Chow test we used a F-statistic table (Backhaus, 2006). If significant differences are found, nationality can be considered a moderator that operates through the error term, often also called 'homologizer' (Sharma et al., 1981). All variance inflation factors (VIFs) in our linear regression models were well below the widely accepted threshold value of 10 (Hair, 2006).

Regarding the *sense of self-worth*, splitting into subsamples results in an improvement of the adj. R<sup>2</sup> value in the German subsample and a decrease of the R<sup>2</sup> value in the Chinese sample. The standardized regression coefficient is higher in regression model of the German subsample. However, the Chow test was not significant, thus Hypothesis 1 has to be rejected. The *sense of self-worth* equally influences the *intention to share knowledge* in the two subsamples.

For the factor *loss of knowledge power* we find considerable differences. Again, we find an improved adj. R<sup>2</sup> value in the German and a decreased adj. R<sup>2</sup> value in the Chinese subsample. Further, we can find the hypothesized negative influence of *loss of knowledge power* on the *intention to share knowledge* in the total sample and the German subsample, but not in the Chinese subsample, where this regression model is not significant. The Chow test is significant at  $p < .01$ , supporting Hypothesis 2. As expected, the *loss of knowledge power* has a negative influence on the *intention to share knowledge* in the German subsample, while the *loss of knowledge power* has no influence on the *intention to share knowledge* in the Chinese subsample.

Separation into subsamples regarding *guanxi orientation* results in an improvement of the model fit in both subsamples. The adjusted adj. R<sup>2</sup> rises from .705 to .757 in the Chinese

Table 1 Results of linear regression analysis and Chow tests: intention to share knowledge as dependent variable.

Variables	Total sample			Chinese group			German group			Sub-groups different?
	Beta	R <sup>2</sup>	Adj. R <sup>2</sup>	Beta	R <sup>2</sup>	Adj. R <sup>2</sup>	Beta	R <sup>2</sup>	Adj. R <sup>2</sup>	
Sense of self-worth	.872**	.761	.755	.844**	.713	.694	.885**	.783	.774	No
Loss of knowledge power	-.493*	.243	.225	.310	.069	.036	-.736**	.541	.522	Yes**
Guanxi orientation	.844**	.712	.705	.879**	.772	.757	.850**	.722	.711	Yes*
Face saving	.278	.077	.055	.538*	.289	.242	.172	.030	-.011	No

Notes: N = 43; n<sub>China</sub> = 17; n<sub>Germany</sub> = 26; \*significant at  $p < .05$ ; \*\*significant at  $p < .01$ ; F-values for Chow tests from Backhaus (2006).

se subsample and to .711 in the German sample, respectively. The standardized regression coefficients as well increase from .844 to .879 and .850 in the Chinese and German subsamples. The Chow test is significant at the level of  $p < .05$ , providing support for Hypothesis 3. Thus we demonstrated that the influence of *guanxi orientation* has a stronger influence on the *intention to share knowledge* in the Chinese than in the German group.

Lastly, we find an improvement of the adj.  $R^2$  value in the Chinese subsample and a decrease of adj.  $R^2$  in the German subsample, segmenting into subgroups in the regression model with *face saving* as the independent variable. Furthermore, *face saving* has only a significant influence on the intention to share knowledge in the Chinese subsample. Nevertheless, none of the three regression models demonstrates the hypothesized negative influence. Additionally the Chow test is not significant, disproving Hypothesis 4.

## 7 Discussion and conclusion

This study offers several interesting findings regarding personal and cultural impacts on the process of knowledge sharing in cross-cultural collaborative R&D projects. Particularly, the regression models allow us to identify success factors and barriers influencing the intention to share knowledge of collaborating researchers, contributing to the existing body of literature by considering an academic and cross-cultural perspective. Furthermore, we find considerable differences in the influencing factors between Chinese and German groups that can be related to cultural impacts.

The *sense of self-worth* demonstrates an equally positive influence in both subsamples on an individual's *intention to share knowledge*. However, while the Germans' individualistic orientation and the low power distance index as a facilitator of giving feedback could enhance the importance of self-worth in Germany, the Chinese desire to gain face as a facilitator to increase one's *sense of self worth* could explain the importance of this construct in the Chinese group. Nevertheless, we could show the importance of *sense of self-worth* for the *intention to share knowledge* in a cross-cultural academic setting, supporting the findings of Bock et al. and Qian et al. (Qian et al., 2008). Hence, researchers in collaborative projects should establish frequent feedback rounds, in which past knowledge sharing activities

are analyzed in a way that individuals see how their contribution in knowledge sharing processes has improved the projects' performance. Such discussions would allow participants to increase their *sense of self-worth* and would further have a positive impact on their *intention to share knowledge*, enhancing future knowledge sharing activities.

Significant differences emerge in the regression model with *loss of knowledge power* as the independent variable. In the German subsample we could demonstrate a negative influence of *loss of knowledge power* on the *intention to share knowledge*. The German society is characterized by an individualistic orientation. We argue that this orientation enhances the fear of losing competitive advantages, even in academic settings. On the contrary, in the Chinese subsample *loss of knowledge power* has no significant influence on the *intention to share knowledge*. However, previous research in a Chinese setting could show that *loss of knowledge power* has a negative influence in knowledge sharing processes in an economic setting (Bock et al., 2005; Qian et al., 2008). Interestingly, we cannot support Qian's findings in our academic setting, implying that Chinese academic researchers are not afraid to lose competitive advantages through knowledge sharing. Instead, by sharing superior intellectual knowledge scientists could gain face, which is highly important in Chinese societies (Brunner et al., 1989). Besides, Kankanhalli et al. could not prove their hypothesized negative impact of *loss of knowledge power* in knowledge sharing processes in their setting either (Kankanhalli et al., 2005). Further examinations regarding setting impacts could give new impetus to the concept's continuous development.

As hypothesized, the *guanxi orientation* has a significantly stronger positive influence on the *intention to share knowledge* in the Chinese subgroup. Furthermore, in the Chinese group *guanxi orientation* has the strongest influence on the *intention to share knowledge* in all regression models, highlighting the outstanding social relationship orientation. Thus, we could demonstrate that a cultural factor has a larger impact on knowledge sharing processes than personal factors, supporting findings of Qian et al.. As Qian et al. further pointed out, Chinese try to create a harmonious atmosphere, which enables knowledge sharing in the first place and facilitates the building of reciprocal relationships (Qian et al., 2008). Surprisingly, the standardized cor-

relation coefficient of .850 in the German subsample is also considerably high. Accordingly, social relations have an important influence on the *intention to share knowledge* in the German subsample, too. Niedergassel, for instance, demonstrated in a German academic setting that knowledge sharing is enhanced if the relationship between collaborators is particularly close (Niedergassel and Leker, 2009). However, the Chinese *guanxi orientation* is a unique phenomenon and has to be closely considered when striving for collaboration with Chinese partners. Maintaining a good relationship to Chinese partners by exchanging favors and following the unwritten law of reciprocity is a key strategy for successful collaboration (Davies et al., 1995; Dunning and Kim, 2007; Lockett, 1988; Valentine and Godkin, 2001; Zhang et al., 2008).

Finally, we could not demonstrate the hypothesized negative effect of *face saving* on the *intention to share knowledge* in neither of the subgroups. Furthermore, the Chow test is not significant, disproving our hypothesis. Thus, we cannot support the findings of Qian et al., who could demonstrate a negative influence of *face saving* and a positive influence of face gaining on the intention to share (Qian et al., 2008). Therefore, we argue that multiple facets of the concept of face have to be considered. However, Zhang et al. pointed out that saving face is less important to Chinese when interacting with foreigners, since one can only lose face to members of one's social environment (Zhang et al., 2008). Accordingly, Ardichvili et al. argue that the impact of the concept of face was weaker than expected in their study, too (Ardichvili et al., 2006). They suggest, that Chinese feel rather comfortable asking questions and contributing to discussions if such interactions improve project performance (Ardichvili et al., 2006). Further, Ardichvili et al. reason that face saving is more a concern for older Chinese (Ardichvili et al., 2006). Nevertheless, we still believe that the concept of face has a strong impact on any interaction in collaborative activities with Chinese partners. Thus, we emphasize that one should carefully focus on consequences and implications of face, when collaborating with Chinese partners. For instance, giving face, i.e. doing something that enhances someone else's reputation or prestige by praising, gift giving or concessions can improve the performance of collaborations with Chinese partners (Cardon and Scott, 2003).

While offering many interesting findings, this study also possesses some limitations

requiring consideration. Our study is based on a comparatively small sample size and we focused on a knowledge generation oriented academic setting, thus generalizing our results to economic situations may not be appropriate. However, we will conduct qualitative interviews to support the findings of our quantitative analysis. Besides, we especially focused on Chinese cultural factors, though future research should investigate cultural characteristics of western societies that might influence knowledge sharing processes. Generally, strategies, non-monetary rewarding and incentive systems facilitating knowledge sharing should be developed and discussed more deeply.

Despite the limitations we still believe to make a valuable contribution to the existing body of literature on cross-cultural knowledge sharing in innovation, technology and collaboration management, particularly considering the academic partners' point of view and the increasing importance of collaborative activities with partners from China.

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## Appendix

### Appendix 1 Constructs, items, factor loadings, Cronbach's alphas, VE.

<i>Questionnaire items</i>	<i>Loading</i>
<b>Sense of self-worth (5 items, Cronbach's alpha = .936 VE = .803)</b>	
My knowledge sharing would help other members in the organization solve problems.	.942
My knowledge sharing would create new opportunities for the organization.	.868
My knowledge sharing would improve work processes in the organization.	.921
My knowledge sharing would increase productivity in the organization.	.864
My knowledge sharing would help the organization achieve its performance objectives.	.883
<b>Loss of knowledge power (4 items, Cronbach's alpha = .892 VE = .756)</b>	
Sharing my knowledge makes me lose my unique value in the organization.	.810
Sharing my knowledge makes me lose my power base in the organization.	.892
Sharing my knowledge makes me lose my knowledge that makes me stand out with respect to others.	.909
Sharing my knowledge makes me lose my knowledge that no one else has.	.862
<b>Guanxi orientation (6 items, Cronbach's alpha = .874 VE = .622)</b>	
We expect that our friends will help us in our social life.	.638
Our society is composed of a kind of personal relation net.	.748
I enjoy life that includes human concern and kindness.	.860
Personal relations are an important resource in career development.	.664
People should get on with each other harmoniously.	.863
I will try to build a good relationship with my colleagues and supervisors.	.917
<b>Face saving (3 items, Cronbach's alpha = .571 VE = .541)</b>	
I pay a lot of attention to how others see me.	.617
I am usually very particular about the way I dress because I do not want others to look down on me.	.765
I feel a loss of face when others turn down my favor.	.810
<b>Intention to share knowledge (3 items, Cronbach's alpha = .921 VE = .865)</b>	
I will make an effort to share knowledge with my colleagues.	.924
I intend to share knowledge with my colleagues when they ask.	.914
I will share knowledge with my colleagues.	.951

Notes: N = 43; Confirmatory factor analysis was performed using AMOS 16.0. Goodness-of-fit measures for the overall measure model are: GFI = .969; AGFI = .960; RMR = .072.